Title

Serum 25-hydroxy vitamin D concentrations are more deficient/insufficient in peritoneal dialysis than haemodialysis patients in a sunny climate.

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ABSTRACT

Background: Research has identified associations between serum 25(OH)D and a range of clinical outcomes in the chronic kidney disease and wider populations. The study aim was to investigate vitamin D deficiency/insufficiency in dialysis patients and the relationship with vitamin D intake and sun exposure.

Methodology: A cross-sectional study was used. Participants included 30 peritoneal dialysis (43.3% male; 56.87±16.16 y) and 26 haemodialysis patients (80.8% male; 63.58±15.09 y) attending a department of renal medicine.

Explanatory variables were usual vitamin D intake from diet/supplements (IU/d) and sun exposure (minutes/day) Vitamin D Intake, sun exposure and ethnic background were assessed by questionnaire. Weight, malnutrition status and routine biochemistry were also assessed. Data was collected during usual department visits. The main outcome measure was serum 25(OH)D (nmol/L).

Results Prevalence of inadequate/insufficient vitamin D intake differed between dialysis modality with 31% and 43% insufficient (<50nmol/L) and 4% and 33% deficient (<25nmol/L) in HD and PD patients respectively (P<0.001). In HD patients, there was a correlation between diet and supplemental vitamin D intake and 25(OH)D (ρ=0.84, P<0.001) and average sun exposure and 25(OH)D (ρ=0.50, P<0.02). There were no associations in PD patients. Results remained significant for vitamin D intake following multiple regression, adjusting for age, gender and sun exposure.

Principal Conclusions Results highlight a strong association between vitamin D intake and 25(OH)D in HD but not PD patients, with implications for replacement recommendations. Findings indicate that even in a sunny climate many dialysis patients are vitamin D deficient highlighting the need for exploration of determinants and consequences.

INTRODUCTION

In chronic kidney disease (CKD) patients, observational research has identified an association between serum 25(OH)D and a range of clinical outcomes including mortality, albuminuria, cardiovascular events, coronary artery calcification, bone fractures and CKD progression (Nigwekar et al., 2012). Maintaining adequate levels of vitamin D in this population reflects guideline recommendations for monitoring and treating low serum 25(OH)D in CKD patients (Kidney Disease Improving Global Outcomes Work Group, 2009, Kidney Disease Outcomes Quality Initiative, 2003) and could confer health benefits.

While optimal serum 25(OH)D concentrations have not been established in either the general or CKD populations, there is consensus that levels of 25(OH)D below 25 nmol/L indicate "deficiency" and below 50 nmol/L indicate "insufficiency" (Kimlin et al., 2007). However alternative minimum targets of 75 nmol/L or 100 nmol/L have been suggested (Holick, 2005), resulting in a lack of consistency across research in dialysis populations. Irrespective of the targets selected, multiple studies have shown notable proportions of participants with suboptimal 25(OH)D concentrations. For example levels below 37 nmol/L have been reported in 19.5 to 92% of peritoneal dialysis (PD) (Bindal and Taskapan, 2011, Elder, 2007, Nolph et al., 1984, Taskapan et al., 2006, Wang et al., 2008) and 13 to 86% of haemodialysis (HD) patients (Anand et al., 2011, Barreto et al., 2009, Boudville et al., 2010, Chang et al., 2012, Coen et al., 2005, Del Valle et al., 2007, Elder, 2007, Gonzalez et al., 2004, Gracia-Iguacel et al., 2010, Jean et al., 2008, Lee et al., 2012, Milinkovic et al., 2009, Mucsi et al., 2005, Pecovnik-Balon et al., 2009, Saab et al., 2007, Tolouian et al., 2010).

The substantial variation in 25(OH)D concentration between individuals and groups could be due to factors including latitude, skin pigmentation, vitamin D intake from food and supplements and sun protection culture (Holick, 2005). In addition, there is a range of factors specific to dialysis patients that may further explain the aetiology of vitamin D deficiency/insufficiency in this group, in particular but not limited to: lower dietary intake (Korkor et al., 2009) possibly due to dietary restrictions and decreased appetite; limited mobility and time outdoors (Clayton and Singer, 2009, Korkor et al., 2009); reduced synthesis of cholecalciferol in the skin due to reduced glomerular filtration rate (Michaud et al., 2010); and losses in the peritoneal fluid (Sahin et al., 2009). However, the evidence discriminating between dietary and sun exposure sources of vitamin D is scant. One previous study investigated vitamin D intake in stages 3 to 5 CKD, but only 20% of the participants were stage 5 (Holden et al., 2010). Four studies investigated vitamin D intake from diet and/or supplements in kidney transplant recipients (Ewers et al., 2008, Lynch et al., 2007, Heaf et al., 2004), or stages 3 and 4 CKD patients (Sekkarie, 2006), all of whom have dietary restrictions that differ from dialysis patients (Ash et al., 2006). Only two studies have investigated sun

exposure in CKD patients – within kidney transplant recipients (Ewers et al., 2008) and dialysis patients (Del Valle et al., 2007).

While cross-sectional studies have found that low serum 25(OH)D is an issue in dialysis patients, Australian studies conducted in Canberra (Clayton and Singer, 2009), Sydney (Elder, 2007) and Perth (Boudville et al., 2010) provide little evidence for patients in subtropical climates such as Brisbane. One Brisbane study of stage 1 to 5 pre-dialysis patients found 10% and 42% of patients with 25(OH)D levels below 37.5 nmol/L and between 37.5 to 75 nmol/L, respectively (Petchey et al., 2012). Studies of the general population in Brisbane report 25(OH)D deficiency and insufficiency in 10% and 31% respectively (Kimlin et al., 2007). None of these studies, however, distinguished contributions from sun exposure behaviours, usual dietary vitamin D intake and vitamin D supplements. The aim of this study therefore was to investigate the serum 25(OH)D levels of HD and PD patients attending a large tertiary hospital in Brisbane and to examine the contribution of sun exposure, vitamin D intake from food and supplements towards serum 25(OH)D levels. This work will provide further data on the prevalence of vitamin D deficiency/ insufficiency in dialysis patients and the relationship with dietary and sun exposure behaviours and inform the development and implementation of intervention strategies.

METHODS

Study design and participants

This cross-sectional study recruited patients within the Department of Renal Medicine at The Royal Brisbane and Women's Hospital (RBWH).

Participants were male and female patients aged over 18 years undergoing PD or HD. Exclusion criteria were inability to communicate in English or lack of cognitive capacity to consent or participate. Potential participants were identified through renal unit records and screened for eligibility by examination of medical records and discussion with nursing staff. All eligible PD and HD patients were mailed an information pack indicating they would be invited to participate during their clinic visit in the following week. Data were collected from PD patients during their routine clinic visit across August to December 2009 inclusive and from HD patients during their HD treatments over two weeks in December 2010. Data were collected for two student research projects conducted one year apart.

PD patients were contacted by telephone. If consent was given, data were collected around the time of their next clinic appointment. HD patients were approached during their regular dialysis treatment and data collected at that time. Informed consent was obtained for 56 participants, including 30 of 78 (37%) of the PD program and 26 of 40 (65%) of the HD program. Of these, one PD and seven HD participants did not complete the dietary vitamin D intake and sun exposure section of the questionnaire. The RBWH Research Ethics Committee and Queensland University of Technology (QUT) Human Research Ethics Committee approved the study protocol.

Variables and data sources/measurement

AusSun General Health and Sun Skin and Diet Questionnaires

The AusSun General Health and Sun Skin and Diet Questionnaires (AusSun) were modified to include only the sections on ethnic origin, sun exposure and dietary and supplemental vitamin D intake. Sections on education, occupation, smoking, alcohol, general health were excluded as they were not deemed relevant to this study. Information on medication was able to be extracted from medical charts if needed. Data were collected by a dietitian or final year dietetics student who had completed all clinical placements required by the university.

Investigators recorded the use of inactive vitamin D supplements (cholecalciferol), including brand name, dose and frequency of use over the previous month. Specific vitamin D content of supplements was sourced from MIMS online, the AUSNUT 2007 supplement composition database (Australian Government., 2007) or by contacting pharmaceutical companies. Dietary vitamin D intake was assessed using the targeted food frequency questionnaire (FFQ) including foods and beverages with naturally occurring or fortified vitamin D (AusSun). Participants self-reported their usual intake compared to a standard serve and average frequency of consumption over the previous month. Food models and standard utensils were used to improve estimation accuracy. The vitamin D content of all items was sourced from published Australian values from the AUSNUT 2007 nutrient composition database (Australian Government., 2007). Vitamin D intake was analysed as a continuous variable and also dichotomized according to whether participant's intake was above the Nutrient Reference Value for their age and gender (Commonwealth of Australia., 2006).

Participants estimated time spent outdoors for each hour between 5am and 7pm each day over the previous month. Available responses were: never, <15 minutes, 15-30 minutes, 30-45 minutes or 45-60 minutes. Data were summed for daily exposure using the lowest, highest and mid-point for each response and averaged for weekdays, weekends and overall. Time spent outdoors was analysed as a continuous variable and a dichotomous categorical variable based on whether duration

was less than or equal to 30 minutes per day versus more than 30 minutes a day. Summation is a well-established measure to assess the exposures of individuals by calculating an average of the large day-to-day variability and has been used in previous studies using questionnaires or activity logs to estimate exposure (Kimlin et al., 2007, Parisi et al., 2000).

Serum 25-OHD

Non-fasting blood samples were taken from the participants at the RBWH, centrifuged, and transported to QUT within two hours of venipuncture then frozen at -80°C. Serum 25(OH)D was measured on all samples as a single batch using a commercial chemiluminescent immunoassay (LIAISON_ 25(OH) Vitamin D TOTAL Assay, DiaSorin, Inc., Stillwater, MN). This assay measures both 25(OH)D2 (ergocalciferol) and 25(OH)D3 (cholecalciferol) (AusSun). Intra-assay variability was 3-6% for serum 25(OH)D. Corresponding values for inter-assay variability were 6-9%. The laboratory undertaking the testing is a participant in the Vitamin D External Quality Assessment Scheme (DEQAS).

Participant Characteristics

Nutritional status was assessed by the patient-generated subjective global assessment (PG-SGA) (Detsky et al., 1987) by research staff. If dietetic staff had conducted a routine PG-SGA within the same week as data collection a separate PG-SGA was not collected. Nutritional status categories were well-nourished (A), moderate or suspected malnutrition (B) or severely malnourished (C). The most recent dry weight available, assessed by nursing staff, was extracted from patient charts. Height was self-reported. Body mass index (BMI) was calculated as body weight divided by squared height. BMI $\geq$ 23 kg/m^2 and $\leq$ 26 kg/m^2 was used to reflect optimal nutritional status (Ash et al., 2006). The use of a BMI range higher than the 18.5 to 25 kg/m^2 recommended for the healthy population (World Health Organization., 2000) is based upon evidence suggesting a lower BMI is associated with higher mortality rates in dialysis patients (Salahudeen, 2003).

Age, dialysis vintage (months since commencement), height, routine biochemistry (phosphate, potassium, albumin and urea) and blood pressure were obtained from participant charts. Kt/V (dialyser clearance of urea multiplied by time over volume of distribution of urea) was used as a marker of dialysis adequacy. In Australia the target recommended for Kt/V is $\geq$1.4 to ensure the delivered dose is above 1.2 for HD patients (Kerr et al., 2005). For PD the weekly target is $\geq$ 1.6/week (Johnson et al., 2005).

Data analysis

Data were analysed in PASW statistics (formerly SPSS) version 19. Patient characteristic data are expressed as median and range or mean and standard deviation according to normality status. To address the aim of investigating vitamin D status in PD and HD groups 25(OH)D was analysed as a continuous and ordinal variable. Cut-points for the categorization of 25(OH)D were ≤ 25 nmol/L for vitamin D deficiency, and between 25 and 50 nmol/L for vitamin D insufficiency based on Australian recommended position statements for vitamin D and adult bone health (Working Group of the Australian and New Zealand Bone and Mineral Society et al., 2005). As minimum targets of 75 nmol/L have also been recommended (Holick, 2005) the percentage of participants above this level was also calculated. For comparison between dialysis groups Student unpaired *t*-tests and Mann-Whitney U tests were used for normal and non-normal continuous data respectively and Pearson's Chi-square tests were used for categorical data.

Spearman's rank-order correlations were used to address the aim of investigating associations between 25(OH)D and vitamin D intake or sun exposure variables . Multiple regression analyses were used to investigate the relationship between Vitamin D intake and serum 25(OH)D, controlling for gender, age and sun exposure in PD and HD groups Standardized beta coefficients were used to investigate the contribution of the explanatory variables towards predicting serum 25(OH)D.

RESULTS

Serum 25-hydroxyvitamin D was measured in 30 PD and 26 HD patients. Of these one PD and seven HD patients did not complete the questionnaire. These participants were excluded from the multiple regression analysis. Ethnicity and BMI data were not reported in three and four HD patients respectively. These participants were not excluded as ethnicity and BMI were not included in multiple regression analysis.

No significant differences were shown for age, gender, dialysis vintage, Kt/V and BMI at the start of renal replacement therapy in participants compared to eligible members of the RBWH population that did not consent to participate and the overall PD and HD population in Australia as identified by ANZDATA (Australia and New Zealand Dialysis and Transplant Registry, data not shown). There were also no significant differences between dialysis modalities for age, ethnic background, dialysis vintage, BMI, serum albumin and serum phosphate between PD and HD (Table 1). A higher proportion of female patients received PD (17/22) compared to males (13/34). When compared to HD, PD patients had lower systolic blood pressure, serum urea and potassium and

higher Kt/V. Malnutrition (SGA score B or C) was identified in 7.7% of PD and 7.1% of HD patients. 20.5% of PD and 15% of HD patients were below optimal BMI (BMI<23kg/m^2) and 51.3% of PD and 55% of HD patients were above optimal BMI (BMI>26kg/m^2). There were no significant differences in malnutrition or BMI status between dialysis groups.

There was a significant and substantial difference between PD and HD patients for prevalence of vitamin D insufficiency/deficiency (Table 2). Using the target of 75 nmol/L 25(OH)D levels were sufficient in 14.3% (n=8) of patients (n=2 (6.7%) and n=6 (23.1%) for PD and HD respectively). There was no difference between dialysis groups for dietary, supplemental or total (dietary plus supplemental) vitamin D intake or sun exposure. Only average sun exposure data are presented, as patterns for estimates of maximum and minimum exposure on weekdays and weekends were similar. Vitamin D intake was below the Nutrient Reference Value for age and gender in 81.6% of PD and 78.9% of HD patients.

Correlations between serum 25(OH)D and vitamin D intake and sun exposure variables are shown in table 3. For PD patients there were no significant associations between serum 25(OH)D and any other variable. In contrast, in HD patients, there were significant and substantial associations between serum 25(OH)D and: total vitamin D intake and supplemental intake; sun exposure - minimum weekday, maximum weekday and maximum weekend. There was a trend for an association with dietary vitamin D intake alone.

Regression weights for the three control variables (gender, age and sun exposure) did not reach or approach significance (Table 4) and were particularly small for sun exposure for both HD and PD groups, indicating sun exposure had little impact upon 25(OH)D levels. The relationship between total intake and 25(OH)D was very strong for HD patients and can be described as: an increased intake of 40 IU (1μg) per day corresponded to an increase of 2.5 nmol/L in 25(OH)D concentration. For PD participants, the relationship was weak and non-significant. These results were similar irrespective of the inclusion of control variables.

DISCUSSION

The finding of a significant correlation between vitamin D intake and serum 25(OH)D for HD but not PD patients has not, to our knowledge, been reported in any other studies. A possible reason for the association in HD but not PD patients could be loss of 25(OH)D in the peritoneal dialysate fluid. A study which found lower 25(OH)D in PD compared to HD patients also reported significantly higher 25(OH)D levels in the peritoneal fluid compared to blood (28. vs. 13.00 nmol/L) (Sahin et al., 2009). There is limited and inconsistent prospective research on the ability of

supplementation to raise 25(OH)D levels in PD patients. One study reported that 27 patients given 41 440 IU of ergocalciferol once per week showed increased 25(OH)D levels, but 26 of the patients remained below 75 nmol/L after four weeks (Bouchard et al., 2008). Another trial of 23 PD patients used 50 000 IU of ergocalciferol per week and only one patient remained below 75 nmol/L (Shah et al., 2005).

Our results showing serum 25(OH)D concentration is higher in patients on HD (53.66 nmol/L) than PD (33.2 nmol/L) are supported by two other Australian studies (Clayton and Singer, 2009, Elder, 2007) that demonstrated levels of 77 and 50 nmol/L in HD and 50 and 35 nmol/L in PD patients respectively. A study in Turkey also found lower levels in PD compared to HD patients (12.5 and 22.5 nmol/L, respectively) (Sahin et al., 2009). Possible reasons for differences in PD and HD patients, apart from loss in peritoneal dialysate, could relate to vitamin D intake and/or sun exposure behaviours. However as PD patients have less restrictive dietary recommendations (Ash et al., 2006) and have greater freedom from dialysis during the daytime these factors do not provide a rationale for lower 25-hydroxyvitamin D in PD patients. Possible confounding factors could also contribute to differences. Age and gender were both adjusted for in multivariable analysis and ethnicity did not have a significant effect on results however other characteristics such as education and living arrangements were not measured. Our data are similar to other studies in Australia which have shown serum 25(OH)D <50 nmol/L in 39% of a combined group of PD and HD patients (Elder, 2007), 49% of HD and 77% of PD (Clayton and Singer, 2009) and 36% of HD patients (Boudville et al., 2010). The proportion of patients with 25(OH)D <50 nmol/L varied to a greater extent across international studies. US studies reported proportions of 97% (Shah et al., 2005) in PD patients and 54 to 77% (Bhan et al., 2010, Blair et al., 2008, Tolouian et al., 2010) in HD patients. In HD patients in Europe prevalence was 28 to 71% in Germany (Drechsler et al., 2010, Krause et al., 2012) Italy (Santoro et al., 2011) and Serbia (Milinkovic et al., 2009). Compared to findings of 25(OH)D deficiency/insufficiency reported in studies of the general Brisbane population of 42.5% (Kimlin et al., 2007) and 31% (McGrath et al., 2001), the proportion of patients was similar in the HD group and higher in the PD group. Overall, studies have indicated the occurrence of sub-optimal 25(OH)D concentration is widespread and across a range of latitudes.

Mean dietary intakes of vitamin D were well below the Australian recommendations of 5 to 15 µg/day (200IU-400IU) depending on age (Commonwealth of Australia., 2006). To our knowledge no other study has assessed vitamin D intake in dialysis patients. Findings were similar to research conducted in kidney transplant patients which reported dietary vitamin D intakes ranging from 120 IU/day (Ewers et al., 2008, Heaf et al., 2004) to 200 IU/day (Lynch et al., 2007) and were lower than average reported intakes of 473.2±380 IU/day from diet and supplements combined in stage 3

to 5 CKD patients (Holden et al., 2010). While supplements improved the intake of the current sample above recommended levels, they were only taken by seven (24%) of the PD and four (21%) of the HD patients and did not significantly increase the median vitamin D intake (Table 2). Other studies that have assessed vitamin D supplementation reported usage by 34.3% of stage 3 and 4 CKD patients in the US (Sekkarie, 2006) and 10.2% and 60.8% of kidney transplant recipients in Ireland (Lynch et al., 2007) and Denmark (Ewers et al., 2008) respectively. The proportion of patients with suboptimal 25(OH)D not taking supplements is in contrast to current guidelines (Kidney Disease Improving Global Outcomes Work Group, 2009, Kidney Disease Outcomes Quality Initiative, 2003) recommending monitoring of 25(OH)D in dialysis patients and treatment using inactive vitamin D supplements (Kidney Disease Improving Global Outcomes Work Group, 2009, Kidney Disease Outcomes Quality Initiative, 2003).

Median daily sun exposure of 39 mins PD and 33 mins HD was above the recommended levels for persons living in Brisbane (6 -7 mins in summer and 15-19 minutes in winter (Working Group of the Australian and New Zealand Bone and Mineral Society et al., 2005)). However exposure ranged from none to 454 mins/day. There is little comparable information about sun exposure and 25(OH)D in CKD patients. A Danish study reported lower 25(OH)D levels of 45 nmol/L in kidney transplant recipients reporting sun avoidance compared to 60 nmol/L in the partial or no sun avoidance group ($P<0.05$) (Ewers et al., 2008). Behaviours in transplant recipients may be influenced by clinical advice on sun protection due to the increased risk of skin cancer with immunosuppression (Feuerstein and Geller, 2008). A study in Argentina reported an association between sun exposure and 25(OH)D ($r=0.55$, $P<0.0001$) in HD patients although the method for assessing exposure was not described (Del Valle et al., 2007).

A limitation of this study is the cross-sectional design so that causal relationships and seasonal changes cannot be determined. An Australian study investigating seasonal variation in 25(OH)D in Sydney found that levels peaked in Summer and Autumn (December to May) and were lowest in Winter and Spring (June to November) (Elder, 2007). As our data was collected between August and early December it is possible that rates of deficiency/insufficiency were underestimated. This study was restricted to a single hospital and only 37.2% of PD and 65% of HD patients agreed to participate, reducing statistical power and generalizability, although national data indicated no significant difference between participants and non-participants for age, gender, Kt/V and BMI. Non-participants and the eight participants that did not complete the questionnaire could differ from participants for factors such as compliance with recommendations and co-morbidities. The differences in recruitment rates between PD and HD patients could also influence comparability of the data. A likely reason for the lower response rate in the PD group was that completion of

measurements required extending the clinic visit whereas data from HD patients was collected during routine dialysis sessions. It is possible that PD patients unable or unwilling to participate were more likely to have lower 25(OH)D and the difference between groups could be greater than that reported.

The ability to identify associations between sun exposure and 25(OH)D may also have been limited by use of self-report data. Participants may not have accurately recalled their sun exposure or the questionnaire may not have captured usual variation. There is also evidence suggesting cutaneous cholecalciferol synthesis could be reduced in persons with lower GFR (Michaud et al., 2010). The 25(OH)D content of dialysate fluid was not measured and therefore could not be investigated to explain the lack of association between intake and 25(OH)D in our PD group. Despite the limitations we were able to identify a very strong relationship between dietary plus supplemental intake and serum 25(OH)D and a trend for an association between dietary intake and 25(OH)D in HD patients. This could be because vitamin D is confined to a relatively small range of foods and due to dietary restrictions CKD patients may be more aware than usual of their intakes.

This study expands the limited data available on vitamin D intake and sunlight exposure of dialysis patients and extends the findings of previous research by identifying an association between vitamin D intake and 25(OH)D in HD but not PD patients. This has implications relating to recommendations for restoration of 25(OH)D in PD patients as current guidelines do not differentiate between dialysis modes. The study provides the first evidence on the occurrence of vitamin D deficiency in persons using dialysis at the latitude of Brisbane and supports previous findings of the higher rate in PD compared to HD patients and the presence of suboptimal 25(OH)D in persons living in a sunny climate. The lack of association between 25(OH)D and sunlight exposure in this group and the reports of suboptimal 25(OH)D in dialysis patients across a range of cultures and latitudes indicate the potential international relevance of these results. Further longitudinal research including vitamin D intake, sunlight exposure, and serum and dialysate 25(OH)D concentration is required to explore these findings. Investigation of the relationship between 25(OH)D and health risks and benefits is also warranted. Research could include larger observational studies conducted across a range of seasons and latitudes and intervention trials to assess the feasibility and efficacy of supplementation and advice in this group.

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607 Table1 – Characteristics of the study population by dialysis mode[1].

Parameter		Peritoneal Dialysis (n=30)	Haemodialysis (n=26)	*P*
Age (years)		56.87±16.16	63.58±15.09	0.1
Gender	Males	13 (43.3%)	21 (80.8%)	0.004
	Females	17 (56.7%)	5 (19.2%)	
Ethnicity[2]	Caucasian	20 (66.7%)	18 (78.3%)	0.3
	Asian	2 (6.7%)	2 (8.7%)	
	PI/PNG	5 (16.7%)	0 (0)	
	ATSI	2 (6.7%)	2 (8.7%)	
	South American	1 (3.3%)	0	
	African American	0	1 (4.3%)	
Duration of dialysis (months)		17.0 (1-70)	22.0 (2-166)	0.4
Body mass index (kg/m^2)[3]		26.3 (19.7-43.4)	26.4 (19.7-43.4)	0.9
PG-SGA Score		4.5 (1-11)	3 (1-14)	0.09
Kt/V		2.51±0.51	1.50±0.39	0.01
Serum phosphorus (mmol/L)		1.64±0.42	1.85±0.62	0.2
Serum potassium (mmol/L)		4.15±0.66	5.03±0.78	<0.001
Serum albumin (g/L)		34 (17-42)	36 (29-40)	0.1
Serum urea nitrogen (mmol/L)		17.76±5.79	20.72±4.66	0.06
Blood pressure (mmHg)	systolic	128.11±23.24	152.05±26.38	0.002
	diastolic	77.57±14.36	69.38±19.12	0.09

608 [1]Values expressed as mean±SD, number (percent) or median (range). Student unpaired t-test or
609 Mann-Whitney U-Test used as appropriate.
610 [2]Ethnicity not reported by 3 HD participants.
611 [3]Weight/height unavailable for 4 HD participants.
612 Abbreviations: PI/PNG, Pacific Islander/Papua New Guinea; ATSI, Aboriginal and/or Torres Strait
613 Island
614

Table 2: Comparison of 25-hydroxyvitamin D status, serum 25-hydroxyvitamin D, vitamin D intake and sun exposure between peritoneal dialysis and haemodialysis patients[1,2]

		Peritoneal Dialysis[5] (n=30)		Haemodialysis[5] (n=26)		*P*
Serum 25(OH)D (nmol/L)		33.10	(12.60-83)	53.7	(10.3-126)	<0.001
Serum 25(OH)D status[3]	Adequate	7	(23.3%)	17	(65.4%)	0.002
	Insufficient	13	(43.3%)	8	(30.8%)	
	Deficient	10	(33.3%)	1	(3.8%)	
Mean time outdoors 5am-7pm (min/d)		39	(0-366)	33	(0-454)	0.4
Mean time outdoors 5am-7pm category:	≥30 min/d	23	(60.5%)	10	(52.6%)	0.6
	< 30 min/d	15	(39.5%	9	(47.4%)	
Dietary vitamin D intake (IU/d)		126.4	(14-300.4)	141.2	(56.8-458.4)	0.2
Supplemental vitamin D intake (IU/d)		1000	(600-2000)	1000	(428-1000)	0.2
Total vitamin D intake (IU/d[4])		140.8	(14-2041.6)	170	(56.8-1311.2)	0.8

[1]Non supplement users excluded (n=7 PD, n=4 HD).

[2]Values expressed as median (range) or number (percent). *P* calculated using Pearson's Chi-Square test or Mann-Whitney U-Test, as appropriate.

[3]Cut-points for 25(OH)D were: deficient, ≤ 25 nmol/L; insufficient, >25 to 50 nmol/L; adequate, ≥ 50 nmol/L.

[4]Total vitamin D intake calculated as the sum of dietary and supplemental intake.

[5]Dietary vitamin D intake and sun exposure questions not available for 1 PD and 7 HD participants.

Abbreviations: 25(OH)D, 25-hydroxyvitamin D; NRV, Nutrient Reference Values (National Health and Medical Research Council, 2006)

631 Table 3: Correlations between 25-hydroxyvitamin D and vitamin D intake or sun exposure in
632 peritoneal dialysis and haemodialysis patients[1]

	Peritoneal Dialysis[3] (n=29)		Haemodialysis[3] (n=19)	
Dietary vitamin D intake	-0.062	(0.7)	0.45	(0.06)
Supplemental vitamin D intake	0.094	(0.6)	0.62	(0.001)
Total vitamin D intake[2]	-0.056	(0.8)	0.84	(<0.001)
Sun exposure average	-0.030	(0.9)	0.53	(0.02)
Sun exposure minimum week days	0.003	(0.9)	0.45	(0.05)
Sun exposure maximum week days	0.22	(0.3)	0.504	(0.03)
Sun exposure minimum weekends	-0.23	(0.2)	0.42	(0.08)
Sun exposure maximum weekends	-0.008	(0.9)	0.49	(0.04)

633 [1]P values (indicated in brackets) calculated using Spearman's rank-order correlation.
634 [2]Total vitamin D intake calculated as the sum of dietary and supplemental intake.
635 [3]Dietary vitamin D intake and sun exposure questions not available for 1 PD and 7 HD participants.
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Table 4: Multiple regression predicting serum 25-hydroxyvitamin D from total vitamin D intake.

Group	Group	B (U. Coef.)	S.E. (B)	95% CI for B	ß (R. Coef.)	*P*
Peritoneal dialysis	Gender	-11.63	7.79	[-27.70, 4.45]	-.320	0.1
	Age (years)	-0.21	0.23	[-0.69, 0.27]	-.186	0.4
	Average sun exposure (min/d)	0.001	0.039	[-0.08, 0.08]	.003	0.9
	Total vitamin D intake (IU/d)	0.25	0.27	[-0.31, 0.802]	.192	0.4
Haemodialysis	Gender	-10.26	7.95	[-27.43, 6.92]	-.122	0.2
	Age (years)	0.039	0.22	[-0.44, 0.52]	.019	0.9
	Average sun exposure (min/d)	0.005	0.026	[-0.05, 0.06]	.021	0.8
	Total vitamin D intake (IU/d)	2.51	0.25	[1.97, 3.06]	.919	<.001

Abbreviations: B (U. Coef.), Unstandardized coefficient); S.E. (B), standard error of B; 95% CI for B, 95% confidence interval for B; ß (R. Coef.), Standardized regression coefficient.